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Sorubim cuspicaudus, a new long-whiskered catfish from northwestern South America (Siluriformes: Pimelodidae)

Michael W. Littmann, Brooks M. Burr, and Pedro Nass

(MWL) Department of Ichthyology, The Academy of Natural Sciences, Philadelphia, Pennsylvania 19103, U.S.A.;
(BMB) Department of Zoology & Center for Systematic Biology, Southern Illinois University at Carbondale, Carbondale, IL 62901-6501, U.S.A.;
(PN) Av. Santiago Marino, C.C., Margarita Plaza Z.P. 6301, Isla de Margarita, Estado Nueva Esparta, Venezuela, P.O. Box 1196

Abstract.—*Sorubim cuspicaudus*, new species, is diagnosed herein as the only member of the genus known to occur west of the Andean Cordillera Oriental, occurring in the Sinu, Cauca, and Magdalena Rivers of Colombia and the Lago Maracaibo basin of Colombia and Venezuela. It is distinguished from other *Sorubim* species by the following combination of characters: unique caudal fin shape with both lobes pointed; deep, blackened posterior fontanelle groove on the supraoccipital bone; combination of broad head and elongate body shape. *Sorubim cuspicaudus* is known to attain lengths greater than 80 cm, making it the largest species in the genus and thus a valuable food resource.

Resumen.—*Sorubim cuspicaudus* es una nueva especie que se reconoce como la única del género que habita el occidente de la Cordillera Oriental Andina, presente en al Sinu, Cauca, y Magdalena, rios dẹ Colombia y cuenca del Lago Maracaibo de Colombia y Venezuela. Se distingue de las demás especies del género *Sorubim* por la combinación de los siguientes caracteres: forma única de la aleta caudal, con ambos lóbulos aguzados, surco fontanelar posterior del hueso supraoccipital negro oscuro; la relación entre el ancho de la cabeza y la longitud del cuerpo. *Sorubim cuspicaudus* alcanza tallas superiores a los 80 cm, siendo la especie más grande del género y representa un importante recurso en el pesquería comercial.

Recent investigations into the systematic status of species assigned to the genus *Sorubim* (Siluriformes: Pimelodidae) have led to the recognition of a new species from the Maracaibo basin of western Venezuela and the Cauca, Magdalena, and Sinu drainages in northwestern Colombia (Littmann 1998). This area is considered ichthyofaunally depauperate despite its large drainage area and diversity of aquatic habitats (Lundberg et al. 1986). The restricted distribution of this species makes it the only member of the genus found west of the Andean Cordillera Oriental. In addition, the new species is a valuable component of the freshwater commercial fishery in Colombia and continues to provide traditional, artesanal fishermen with subsistence protein.

Species of *Sorubim* are characterized by a shovel-like, projecting upper jaw exposing a large premaxillary tooth patch ventrally, laterally positioned eyes, and a distinct, black horizontal stripe stretching from the snout to the caudal fin. Species of *Sorubim* occur in a variety of stream and lentic habitats and are widely distributed throughout most of the major freshwater drainage basins of tropical and subtropical South America.

Twelve zoological names have been historically associated with the genus *Sorubim* (Table 1). One of these names is now known to apply to a species of *Sorubimichthys* (Lundberg et al. 1989), and an additional five names were published only in the synonymy of other nominal pimelodids (Kottelat 1988, Eschmeyer 1998); these names are not available. Of the six remaining names, only *Sorubim lima* (Bloch & Schneider 1801) and *S. trigonocephalus* Miranda-Ribeiro, 1920 represent valid species. *Sorubim infraoculare* Agassiz, 1829, *S. gerupensis* Natterer, 1858, *S. luceri* Weyenbergh, 1877, and *Sorubim latirostris* Miranda-Ribeiro, 1920, are junior subjective synonyms of *S. lima*, the well-recognized senior name and the most widespread species in the genus. *Sorubim trigonocephalus*, represented from only three specimens, occurs only in the Amazon basin (Littmann 1998). We recognize two additional species of *Sorubim*, both unnamed: one is a slender species that occurs syntopically with *S. lima*, to be described in a separate paper in preparation, and the other is described as new below.

The new species has long been considered conspecific with the widely-distributed *Sorubim lima* (Eigenmann & Eigenmann 1890, Miles 1947, Dahl 1961, 1971; Galvis et al. 1997), although the descriptive information presented herein is in disagreement with the past superficial descriptions of species of *Sorubim*. Despite repeated references to *S. lima* in the literature on Colombian fishes, only Dahl (1971:52) and Galvis et al. (1997:72) have illustrated the taxon we describe here as new. Detailed historical, anatomical, and phylogenetic information, including a systematic review of the genus *Sorubim* will be covered in a manuscript now under preparation.

Methods

Point-to-point measurements were made with dial calipers and recorded to the nearest 0.01 mm following Hubbs & Lagler (1974), Lundberg & McDade (1986), and Lundberg et al. (1991). Measurements, presented as percentage of standard length (SL), were made on the left side of the fish whenever possible. Measurements of small specimens were aided by the use of a Wild dissecting microscope fitted with an ocular micrometer. Distances between fins were taken from landmarks using the terms 'origin' as the anterior and 'insertion' as the posterior points of contact between fin rays or membranes and the body (Cailliet et al. 1996). Fifteen morphometric variables taken from the heads of 17 specimens and 31 taken from the bodies of 8 specimens of the new species were analyzed. Slightly bent specimens were gently forced into a straight position when measured. For comparison, the same set of measurements was made on numerous samples of three other species of *Sorubim*. Effort was made to examine specimens encompassing the known geographic range of the genus.

Gill raker, branchiostegal ray, and vertebral counts were made on cleared and counterstained specimens prepared using methods modified from Pothoff (1984) and Taylor & Van Dyke (1985). Dry skeletons and radiographs were utilized to aid with fin ray and vertebral counts following methods described in Lundberg et al. (1991). Vertebral counts include the fused preural centrum 1 + the ural centrum but do not include 6 vertebral elements fused as part of the Weberian complex. Soft X-rays were used to confirm counts of branchiostegal rays, vertebrae, and anal and caudal fin-rays, following Jenkins and Lachner (1971), Lundberg et al. (1991), and Silfvergrip (1996). Unless otherwise specified, counts of meristic features used in the diagnosis and description are reported as modes with ranges in parentheses. Barbel terminology is as follows: barbels on the anterodorsal surface of the head are termed maxillary; barbels on the ventral surface are termed outer and inner mental barbels, respectively.

A truss network of the body and head shape of *Sorubim* was designed using methods defined in Schaefer (1991), including

Table 1.—List of published names and status of species of *Sorubim* Cuvier 1829. Abbreviations: A = Agassiz; S & A = Spix & Agassiz. Authorship of names used in Spix & Agassiz's ''Brazillian Fishes'' follows Kottelat (1988).

Name	Taxonomic status	Reference
Sorubim caparary A, in S & A 1829	1st published in synonymy of *Platystoma corruscans*; not available	Kottelat 1988, present study
Silurus gerupensis Natterer, in Kner 1858	1st published in synonymy of *Platystoma lima*; not available	Gosline 1945, Fowler 1951, Eschmeyer 1998, Nass 1988
Sorubim infraoculare A, in S & A 1829	1st published in synonymy of *Platystoma lima*; not available	Whitehead & Myers 1971, Kottelat 1988, Nass 1988, Eschmeyer 1998
Sorubim jandia A, in S & A 1829	1st published in synonymy of *Platystoma spatula*; not available	Kottelat 1988, Lundberg et al. 1989
Sorubim latirostris Miranda-Ribeiro 1920	junior subjective synonym of *Sorubim lima*	Littmann et al. (in press)
Silurus lima Bloch & Schneider 1801	valid as *Sorubim lima*	Bleeker 1862, Kottelat 1988, several others
Platystoma luceri Weyenbergh 1877	junior subjective synonym of *Sorubim lima*	Eigenmann & Eigenmann 1890, Gosline 1945, Fowler 1951
Sorubim mena Natterer in Kner 1858	1st published in passing under *Platystoma sturio (Platystomatichthys)* not available	Eschmeyer 1998
Sorubim pirauaca A, in S & A 1829	1st published in synonymy of *Platystoma planiceps*; not available	Lundberg et al. 1989, Eschmeyer 1998
Platystoma planiceps A in S & A 1829	valid as *Sorubimichthys planiceps*	Kottelat 1988, Lundberg 1989
Sorubim trigonocephalus Miranda-Ribeiro 1920	valid taxon	Eschmeyer 1998, others, present study
Platystoma truncatum A, in S & A	synonym of *Pseudoplatystoma*	Littmann 1998

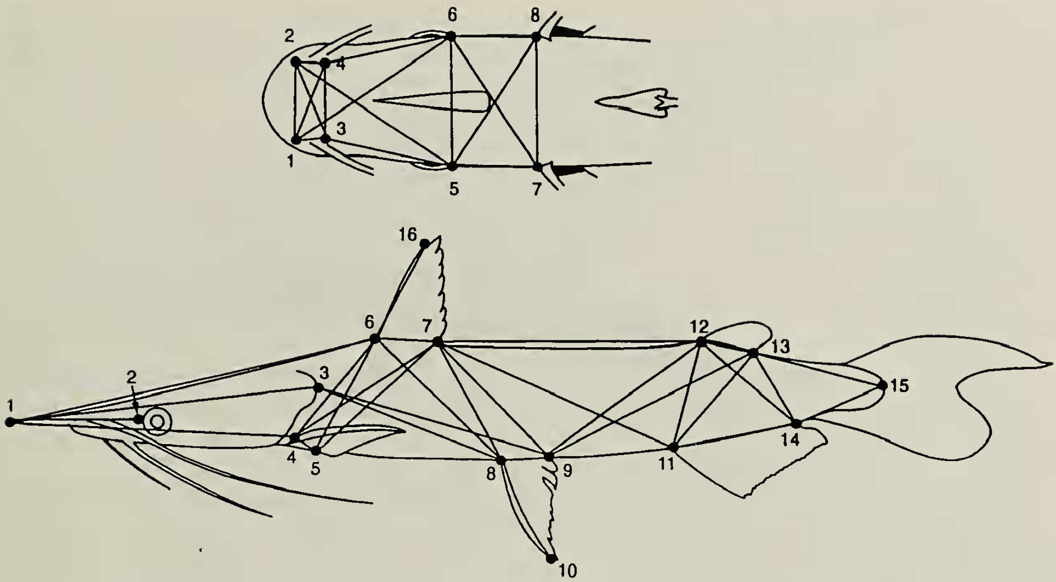


Fig. 1. Diagrammatic representation of 15 head measurements, 31 body measurements, and truss network used in sheared principal component analyses of the species of *Sorubim*. Descriptions of distance measures are provided in Table 2.

46 measurements distributed among three sagittal-plane truss cells with appended posterior and anterior triangles and three dorsal head cells. The truss network consists of a geometric protocol for character selection (Strauss & Bookstein 1982) and incorporates homologous landmarks on the body and head of the fish (Fig. 1). The truss network was used to compare variation in body shape among the different species of *Sorubim*.

Data were analyzed using programs available in SAS 5.18 (SAS Institute Inc. 1997). Multivariate analysis of the morphometric data was accomplished using sheared principal component analysis (PCA) as described by Humphries et al. (1981) and Bookstein et al. (1985) in an effort to eliminate overall size effects. Morphometric characters were log transformed and principal components were factored from the covariance matrix for each analysis, following recommendations by Bookstein et al. (1985).

Institutional abbreviations in text, material examined, and acknowledgments are taken from Leviton et al. (1985) and Leviton & Gibbs (1988).

Sorubim cuspicaudus, new species
Trans-Andean shovelnose catfish (English)
antioqueno, bagre blanco, blanco pobre, blanquillo, cucharo, gallego, Trans-Andean hocico de paleton (Spanish)
Fig. 2b, 3, 4c; Tables 3–8

Holotype.—FMNH 56223, 327 mm SL, Colombia, Departamento de Tolima, Río Magdalena drainage, at Puerto Soplaviento. 11 Jan 1912, C. H. Eigenmann.

Paratopotypes.—FMNH 107492, 2:264–314 mm SL, Colombia, Departamento de Tolima, Río Magdalena drainage, at Puerto Soplaviento. 11 Jan 1912, C. H. Eigenmann.

Paratypes.—FMNH 60305, 3:256–262 mm SL, Colombia, Departamento de Bolivar, Río Magdalena drainage, at Calamar. C. H. Eigenmann. INHS 35428, 145 mm SL, Venezuela, Estado de Zulia, Lago Maracaibo-Río Santa Ana drainage, bridge ca. 8 km SW Alturitas. 2 Feb 1995, L. M. Page et al. CAS 150404, 420 mm SL, 150406, 367 mm SL, Colombia, Departamento de Caldas, at or near junction of Ríos Samana and La Miel, near La Dorada, 05°29′N, 74°40′W. 27 Feb 1957, T. D. White and J. N. Reynolds. AUM 28756, 2:116–191 mm SL, Colombia, Departamento de Bolivar, Río Magdalena drainage, Ciénega de Jobo at confluence with Canal de Dique, 16 km NW Calamar. 3 Oct 1978, J. S. Ramsey, R. Phelps et al.

Diagnosis.—*Sorubim cuspicaudus* is distinguished from all congeners by the following characters: caudal fin deeply forked; distal caudal margin of lower lobe pointed, not curved and rounded as in other species of *Sorubim*, outer principal rays of upper and lower lobes extending straight back (Fig. 2b); posterior fontanelle elongate, forming a conspicuous groove on the supraoccipital bone, externally pigmented black; other species of *Sorubim* without elongate posterior fontanelle, supraoccipital groove, or black external pigment (Fig. 3b); unique in having the combination of an elongate body and broad-shaped head; other *Sorubim* species have either an elongate body and head, or a stout body with a broad head (Fig. 3b).

Description.—Counts of meristic features and morphometric data appear in Tables 3–8. Largest individual examined was 483 mm SL (CU 47915). Dorsal-fin rays ii,6 (n = 23); pectoral-fin rays 9 (8–9); anal-fin rays 19 or 20 (18–22); pelvic-fin rays 6, 1 unbranched and 5 branched (n = 23); principal caudal rays in upper lobe always 8, lower rays variable, 8–10; gill rakers on first branchial arch 15–18, 3 to 4 (usually 4) on epibranchial.

Body shape and form shown in Figure 3. Head broad, but body slender and elongate, tapering from the cleithral process to the caudal peduncle. Head length approximately three times gape width (n = 20, range 2.5–3.4, mean 2.9); interorbital distance three or more times than eye diameter (n = 19, range 3.1–5.1, mean 4.2); anal fin length 1.8–2.3 times adipose fin length (n = 16, range 1.6–2.6, mean 2.1); and premaxillary tooth patch width 2.4 times or more than its length (n = 17, range 2.4–3.2, mean 2.8).

Eyes positioned laterally, visible dorsally and ventrally. Anterior section of lateral line covered externally with very small ossicles (sensu Lundberg & McDade 1986), ovate in shape. Inner mental barbels almost always anterior to or even with gular apex (Fig. 3c). Maxillary barbels extend to pelvic fins. Tooth pattern on vomer highly variable as shown in Fig. 4c. Metapterygoid tooth patches large, fused, and triangular in shape.

Color.—Pigmentation and color variable. Dorsal surface dark to light brown, gray, or black; ventral surface completely white or cream-colored, bisected laterally by a black horizontal stripe extending from tip of snout to the ray tips of lower caudal lobe on its medial edge. Horizontal stripe variable in width, occasionally extending through entire diameter of eye, other times just touching the dorsal edge. Dusky dorsal surface and black horizontal stripe separated by light lateral band, usually white or gray, sometimes light brown.

Fins clear with lemon-yellow at bases of pelvic, anal, and caudal fins, color usually confined to rays, especially in preserved individuals. Fin rays on live or freshly-preserved specimens are primarily clear and lack yellowish color. Posterior rays of anal fin often speckled with melanophores. Most individuals examined had dark, black pigment on outer-most principal caudal-fin rays with a few individuals displaying melanophores on all fin rays. Juveniles exhibit more extensive pigmentation than adults. Maxillary and outer mental barbels pigmented black. Inner mental barbels white, cream, or clear; occasionally pigmented black.

No evidence of sexual dichromatism or dimorphism in any species of *Sorubim* has been identified or reported (Littmann 1998).

Similar species.—*Sorubim cuspicaudus* differs from all other species of *Sorubim* by

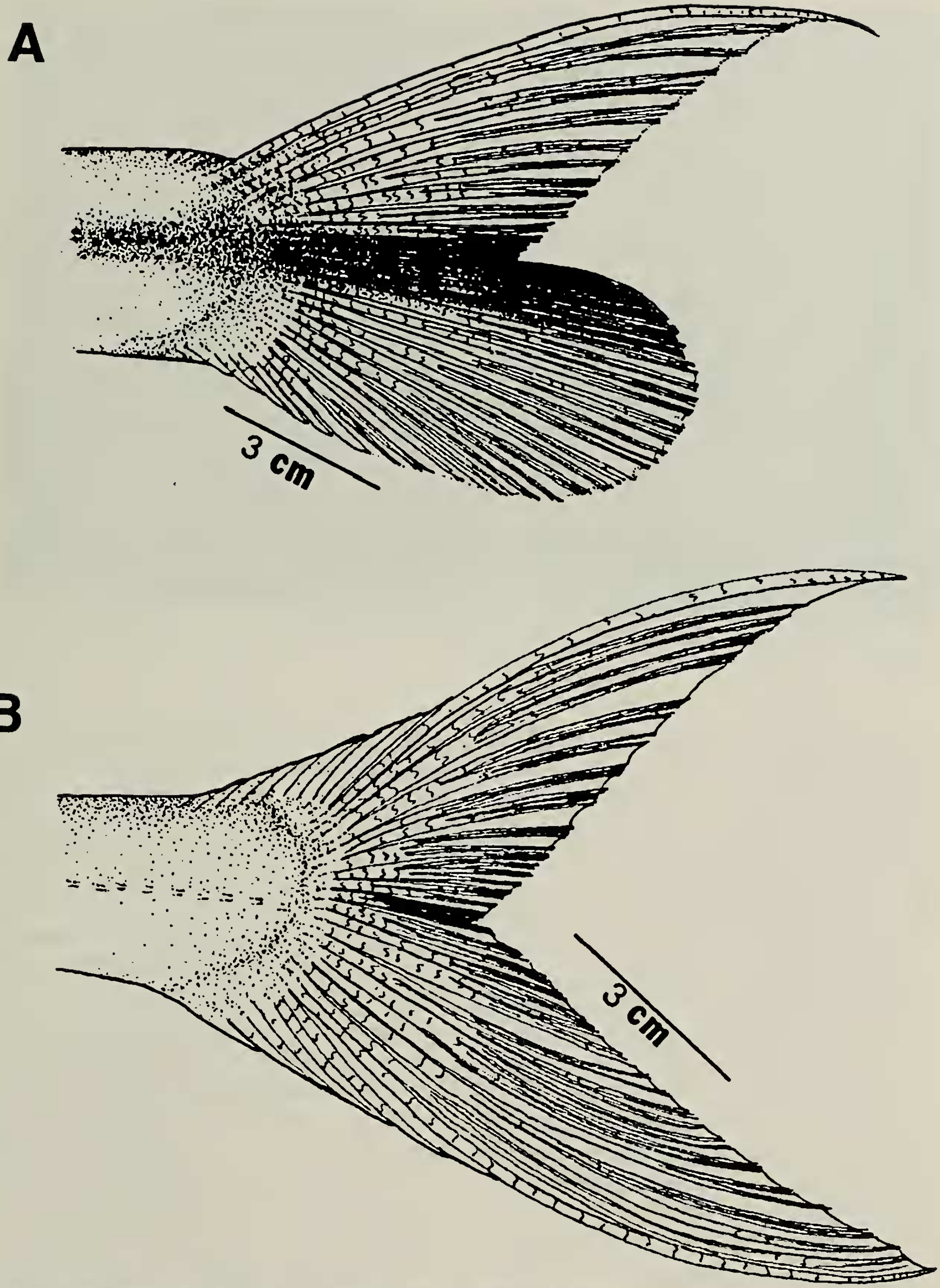


Fig. 2. Schematic illustration of the caudal fin of: A) all species of *Sorubim* except *S. cuspicaudus* n. sp. B) *S. cuspicaudus* n. sp. Illustration by Uriel Buitrago.

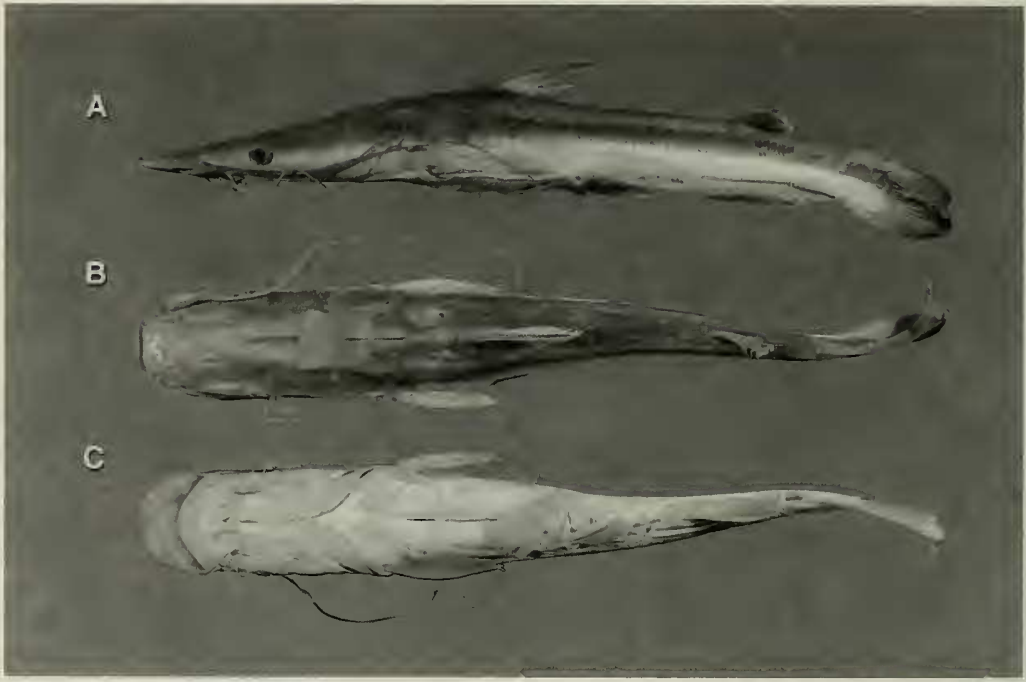


Fig. 3A–C. *Sorubim cuspicaudus* n. sp., holotype, FMNH 56223, 327 mm SL. Photographs by K. S. Cummings.

its unique caudal-fin shape (Fig. 2) and restricted distribution (Fig. 5). It further differs from *Sorubim* n. sp. by having 9 pectoral-fin rays (versus 8), a broader head (Table 9, Fig. 6), and vomerine tooth patches that are connected rather than separated (Fig. 4). Alternatively, the elongate and tapered body shape of *S. cuspicaudus* is similar to *Sorubim* n. sp. but has a relatively longer dorsal spine and dorsal-fin base (Table 10, Fig. 7). The elongate body shape of *S. cuspicaudus* is distinct from the more foreshortened shape of *S. lima* in PCA space (Fig. 7). The new species further differs from *S. trigonocephalus* by having a much shorter premaxillary tooth patch and a broad head that is not triangular in shape. As mentioned in the diagnosis, the combination of a broad head and elongate body is unique within *Sorubim*. *Sorubim lima* has a broad head and fairly stout body, while *Sorubim* n. sp. has both an elongate head and body.

Etymology.—The specific epithet cuspicaudus (from cuspis), Latin for pointed, and -caudus, Latin for tail, refers to the diagnostic pointed caudal-fin lobes. The first part of the English common name "Trans-Andean" describes the general distribution of the fish; the remainder of the name (shovelnose catfish) is familiar to enthusiasts of the aquarium hobby, and differs from that recommended for *S. lima* (i.e., duckbill catfish) by Robins et al. (1991).

Distribution.—*Sorubim cuspicaudus* occurs west of the Andean Cordillera Oriental, and is endemic to three major drainage basins in northwestern South America: Lago Maracaibo, Ríos Magdalena and Sinu (Fig. 5). Miles (1947) reported that this species (as *S. lima*) was not found in the upper reaches of the Río Cauca in northern Colombia. The trans-Andean distribution pattern exhibited by species of *Sorubim* is repeated among other groups of lowland fishes that have been critically examined in recent years (see references in Vari (1988: 350) and Harold & Vari (1994:1)).

Table 2.—Measurements taken on the head and body for morphometric analysis. For diagram of landmark measurements see Figure 1.

Measurement	Truss coordinates
Standard length	1–15
Left anterior nostril to right anterior nostril	1–2
Left posterior nostril to right posterior nostril	3–4
Left anterior nostril to right posterior nostril	1–4
Right anterior nostril to left posterior nostril	2–3
Left anterior nostril to posterior right eye	1–6
Left anterior nostril to left posterior nostril	1–3
Right anterior nostril to posterior left eye	2–5
Left posterior nostril to posterior left eye	3–5
Right posterior nostril to posterior right eye	4–6
Posterior left eye to posterior right eye	5–6
Posterior left eye to right pectoral origin	5–8
Posterior left eye to left pectoral origin	5–7
Posterior right eye to right pectoral origin	6–8
Posterior right eye to left pectoral origin	6–7
Left pectoral origin to right pectoral origin	7–8
Snout length	9–10
Head length	9–11
Snout tip to dorsal origin	9–14
Snout tip to pectoral origin	9–12
Pectoral length at base	12–13
Dorsal length at base	14–15
Dorsal spine length	14–23
Pectoral origin to dorsal origin	12–14
Pectoral origin to dorsal insertion	12–15
Pectoral insertion to dorsal origin	13–14
Pectoral insertion to dorsal insertion	13–15
Posterior margin fleshy operculum to pelvic origin	11-16
Posterior margin fleshy operculum to pelvic insertion	11–17
Pelvic length at base	16–17
Pelvic origin to dorsal origin	16–14
Pelvic origin to dorsal insertion	16–15
Pelvic insertion to dorsal insertion	17–15
Pelvic insertion to adipose origin	17–19
Pelvic insertion to adipose insertion	17–20
Dorsal insertion to anal origin	15–18
Dorsal insertion to adipose origin	15–19
Pelvic insertion to anal origin	17–18
Anal origin to adipose origin	18–19
Anal origin to adipose insertion	18–20
Anal insertion to adipose origin	21–19
Anal insertion to adipose insertion	21–20
Anal fin length at base	18–21
Adipose fin length at base	19–20
Adiose insertion to anterior of caudal fin base	20–22
Anal insertion to anterior of caudal fin base	21–22

Natural history.—Little is known about the biology, life history, and ecology of *S. cuspicaudus*. In the middle and lower Río Magdalena, it occurs in relatively quiet open waters and bays or coves (Dahl 1971, Valderrama & Zarate 1989), is intolerant of low salinity levels, and is not found in estuarine waters (Dahl 1971).

Adult *Sorubim cuspicaudus* undertake upstream spawning migrations called "su-

Table 3.—Measurements of the head expressed in percentage of standard length for 17 specimens of *Sorubim cuspicaudus*. For diagram of landmark measurements taken on head see Figure 1.

Measurement	Holotype	Mean	Range	SD
Standard length	327.00	288.7	139.0–420.0	71.60
Left anterior nostril to right anterior nostril	0.095	0.086	0.075–0.118	0.009
Left posterior nostril to right posterior nostril	0.080	0.073	0.067–0.100	0.008
Left anterior nostril to right posterior nostril	0.091	0.084	0.077–0.113	0.008
Right anterior nostril to left posterior nostril	0.091	0.084	0.077–0.113	0.009
Left anterior nostril to posterior right eye	0.197	0.188	0.175–0.245	0.016
Left anterior nostril to left posterior nostril	0.033	0.031	0.028–0.041	0.003
Right anterior nostril to posterior left eye	0.196	0.187	0.174–0.244	0.016
Left posterior nostril to posterior left eye	0.130	0.125	0.112–0.161	0.011
Right posterior nostril to posterior right eye	0.130	0.126	0.114–0.161	0.010
Posterior left eye to posterior right eye	0.147	0.141	0.127–0.183	0.014
Posterior left eye to right pectoral origin	0.221	0.212	0.195–0.275	0.019
Posterior left eye to left pectoral origin	0.156	0.148	0.136–0.194	0.014
Posterior right eye to right pectoral origin	0.156	0.149	0.137–0.194	0.014
Posterior right eye to left pectoral origin	0.221	0.212	0.194–0.275	0.019
Left pectoral origin to right pectoral origin	0.149	0.148	0.135–0.185	0.011

Table 4.—Measurements taken on the body expressed in percentage of standard length for 8 specimens of *Sorubim cuspicaudus*. For diagram of landmark measurements taken on body see Figure 1.

Measurement	Holotype	Mean	Range	SD
Standard length	327.00	259.4	139.0–327.0	55.55
Snout length	0.203	0.187	0.153–0.203	0.020
Head length	0.370	0.362	0.349–0.372	0.008
Snout tip to dorsal origin	0.463	0.446	0.432–0.463	0.011
Snout tip to pectoral origin	0.349	0.336	0.319–0.350	0.012
Pectoral length at base	0.033	0.034	0.031–0.037	0.002
Dorsal length at base	0.071	0.072	0.069–0.079	0.003
Dorsal spine length	0.164	0.167	0.153–0.173	0.006
Pectoral origin to dorsal	0.166	0.164	0.161–0.168	0.003
Pectoral origin to dorsal insertion	0.217	0.214	0.206–0.225	0.006
Pectoral insertion to dorsal origin	0.153	0.151	0.144–0.156	0.005
Pectoral insertion to dorsal insertion	0.194	0.189	0.181–0.196	0.006
Posterior margin fleshy operculum to pelvic origin	0.222	0.218	0.192–0.238	0.014
Posterior margin fleshy operculum to pelvic insertion	0.252	0.242	0.222–0.252	0.011
Pelvic length at base	0.030	0.032	0.027–0.038	0.003
Pelvic origin to dorsal origin	0.182	0.176	0.164–0.186	0.009
Pelvic origin to dorsal insertion	0.126	0.121	0.108–0.131	0.006
Pelvic insertion to dorsal insertion	0.134	0.130	0.117–0.137	0.008
Pelvic insertion to adipose origin	0.208	0.207	0.193–0.217	0.009
Pelvic insertion to adipose insertion	0.272	0.280	0.272–0.292	0.008
Dorsal insertion to anal origin	0.265	0.265	0.250–0.277	0.009
Dorsal insertion to adipose origin	0.268	0.262	0.250–0.274	0.008
Pelvic insertion to anal origin	0.157	0.169	0.156–0.197	0.016
Anal origin to adipose origin	0.111	0.108	0.097–0.116	0.005
Anal origin to adipose insertion	0.138	0.143	0.137–0.148	0.004
Anal insertion to adipose origin	0.143	0.144	0.139–0.147	0.003
Anal insertion to adipose insertion	0.073	0.072	0.068–0.076	0.003
Anal fin length at base	0.144	0.146	0.130–0.152	0.007
Adipose fin length at base	0.080	0.088	0.075–0.099	0.008
Adipose insertion to anterior of caudal fin base	0.165	0.159	0.145–0.166	0.007
Anal insertion to anterior of caudal fin base	0.120	0.122	0.118–0.130	0.005

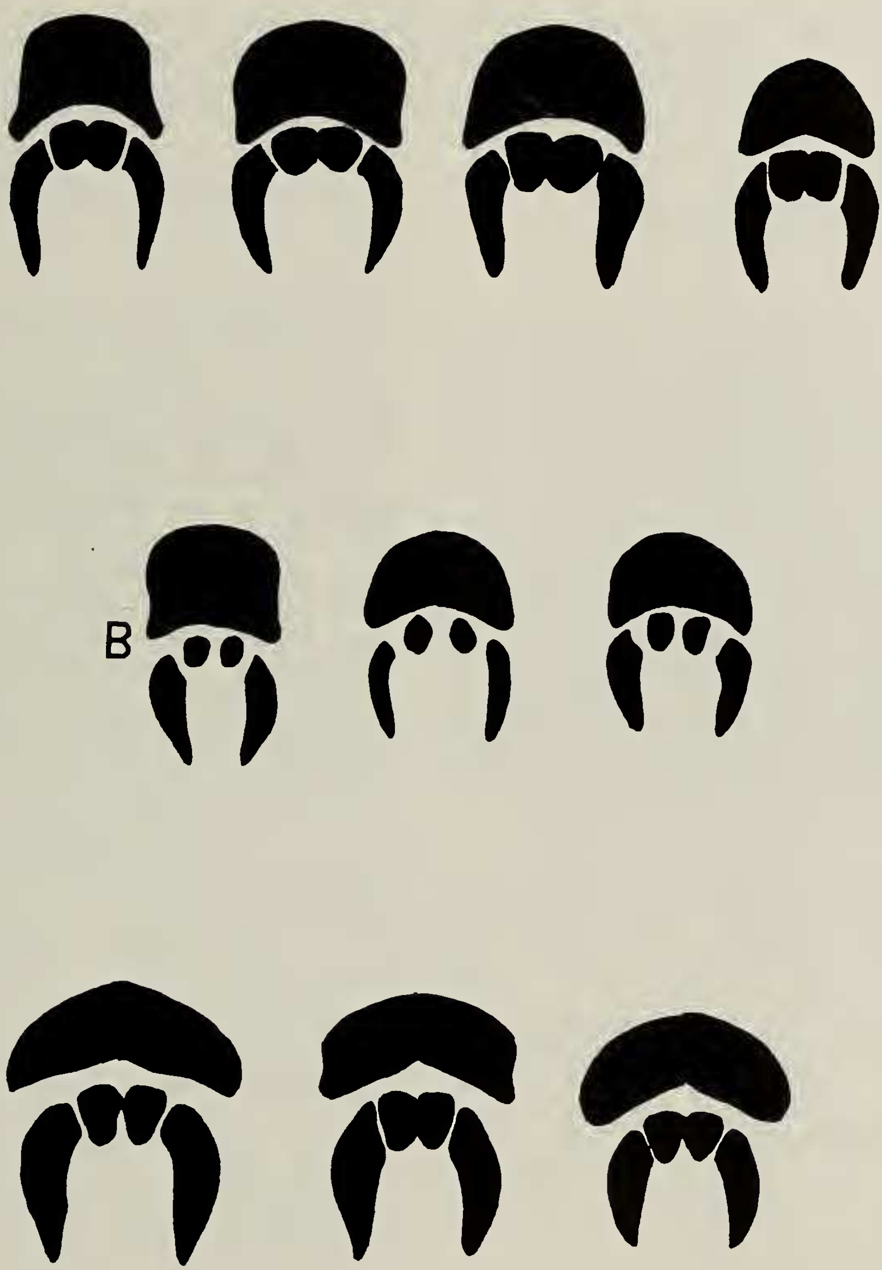
A
B
C


Fig. 4. Ventral view of tooth patterns on upper jaw of: A) *Sorubim lima*, B) *Sorubim* n. sp., and C) *S. cuspicaudus* n. sp.

biendas" during low-water periods (Valderrama & Zarate 1989). The onset of the rainy season initiates reproduction; larvae move downriver along the safety of the banks and littoral zones. Following spawning, adults return to feeding sites in the floodplains during high-water periods called "bajanzas" (Valderrama & Zarate 1989). Hurtado (1972) reported that *Pseudoplatystoma fasciatum*, a putatively close relative of *Sorubim* spp. (fide Lundberg et al. 1991), spawn in the main channels of

Table 5.—Frequency distribution of number of gil rakers on first branchial arch in four species of *Sorubim* (Littmann 1998).

Species	13	14	15	16	17	18	19	20	21	22	23	33	34	35	36	37	n	mean	SD
Sorubim lima	3	27	35	72	22	1											160	15.54	1.008
Sorubim n. sp.			3	7	15	20	12	25	32	5	3						122	19.27	1.881
S. cuspicaudus			6	4	7	4											20	16.45	1.146
S. trigonocephalus	3																3	13.00	0.000

large rivers where strong currents carry larvae downstream. This behavior has been observed by Bayley (1973) who identified a mechanism for larval dispersal and the early migration pattern of *Prochilodus platensis* as being a drift organism (Valderrama & Zarate 1989). In the Río Madeira, other species of *Sorubim* have been observed migrating upstream through cataracts forming large schools with other members of Pimelodidae (e.g., *Pinirampus pirinampu* and *Calophysus macropterus*) (M. Goulding, pers. comm.). Many local fishermen and scientific researchers agree that such migratory schools may travel distances greater than 1000 km to reach an upstream destination at various times of the year depending on seasonal hydrological regimes. Several authors have expanded on the importance of flow regimes, horizontal movements of fish from flooded forests and "varzea" lakes, and other hydrological matters which directly relate to the success and diversity of the aquatic habitat and its surrounding ecosystem (Goulding 1980, Day & Davies 1986, Sioli 1984).

Fisheries.—Within the Río Magdalena watershed, *S. cuspicaudus* serves as an important food resource for both subsistence and commercial fishery operations (Dahl 1971, Valderrama & Zarate 1989, Galvis et al. 1997), occurring 40% of the time in collections made at 29 sampling sites in the Río Magdalena floodplain system (Kapetsky et al. 1977). Escobar et al. (1983) listed minimum and median catch lengths observed at first sexual maturity for several commercially important species, minimum SL for *S. cuspicaudus* was 319 mm for males and 299 mm for females. In a similar report by Arboleda et al. (1984), median catch lengths were approximately 40–48 cm. Unfortunately, fishing pressures on targeted populations have increased because of the use of better equipment (i.e., seine nets), causing conflicts with cast-net fisherman (Valderrama & Zarate 1989), and undoubtedly elevating the ease of harvest for some species. *Sorubim cuspicaudus* is re-

Table 6.—Frequency distribution counts of vertebrae (including fused preural centrum + ural centrum but not fused elements of Weberian complex) for four species of *Sorubim* (Littmann 1998).

Species	44	45	46	47	48	52	*n*	mean	*SD*
Sorubim lima	1	6	17	11	1		36	46.59	0.590
Sorubin n. sp.	2	3	3				8	45.13	0.835
S. cuspicaudus		4	1				5	45.20	0.447
S. trigonocephalus						1	1	52.00	0.000

ported to attain a SL of 800 mm or more (Galvis et al. 1997, D. Taphorn, pers. comm.).

Bayley and Petrere (1989) indicated that the potential overharvest of at least one pimelodid species, *Pseudoplatystoma fasciatum*, is imminent. As of 1989, the establishment of temporary fishing bans on this species were considered because of the repeated occurrence of smaller catch sizes relative to the median size reported at maturity. Regulations could have direct impacts on populations of *S. cuspicaudus*. Temporary fishing bans on large catfishes have forced fishermen to bring larger quantities of some smaller species to market that have not been previously utilized commercially. Many authors (Bayley 1981, Bayley & Petrere 1989, Novoa 1989, M. Goulding, pers. comm.) have noted that the majority of fish species in tropical South America are indeed underutilized as food. Thus, the continued collection of annual catch and harvest data are needed for future monitoring of *S. cuspicaudus* to help insure its sustainability as a valuable fishery resource.

Biogeography.—Eigenmann (1920) was apparently the first to recognize a "horizontal distribution of fishes," or close similarity in fish faunal composition between the

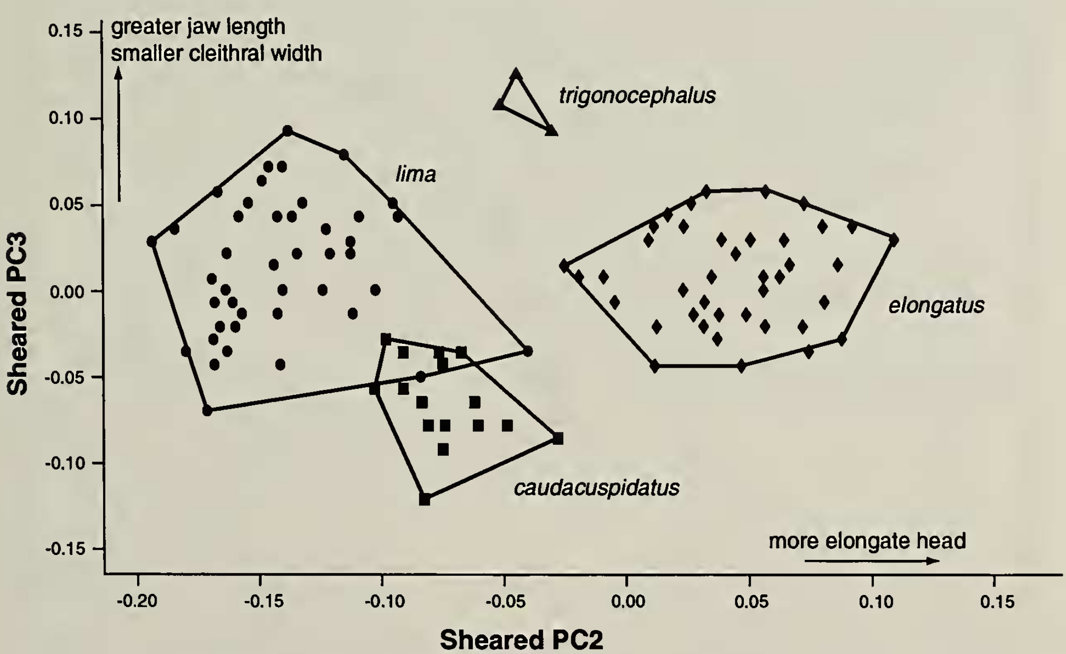


Fig. 5. Morphometric scores of head measurements on sheared PC axes 2 and 3 for 45 specimens of *Sorubim lima*, 43 specimens of *Sorubim* n. sp., 17 specimens of *S. cuspicaudus* n. sp., and three specimens of *S. trigonocephalus*.

Table 7.—Frequency distribution of number of pectoral fin rays in species of *Sorubim* (Littmann 1998).

Species	7	8	c	9	10	*n*	mean	*SD*
Sorubim lima		4		146	10	160	9.038	0.294
Sorubim n. sp.	7	112		3		122	7.967	0.288
S. cuspicaudus		1		19		20	8.950	0.223
S. trigonocephalus				3		3	9.000	0.000

Magdalena and Orinoco rivers. He included a list of genera and species found on both sides of the Cordillera of Bogota, concluding that the fish fauna of the Magdalena basin was derived "in small part from the ocean and in larger part from Central America," and that "most of it had an origin in common with that of the Orinoco basin fauna" to the east (Eigenmann 1920, p. 34). One interesting conclusion noted by Eigenmann was that, "the stripes found on the large catfish, the bagre tigre (*Pseudoplatys-*

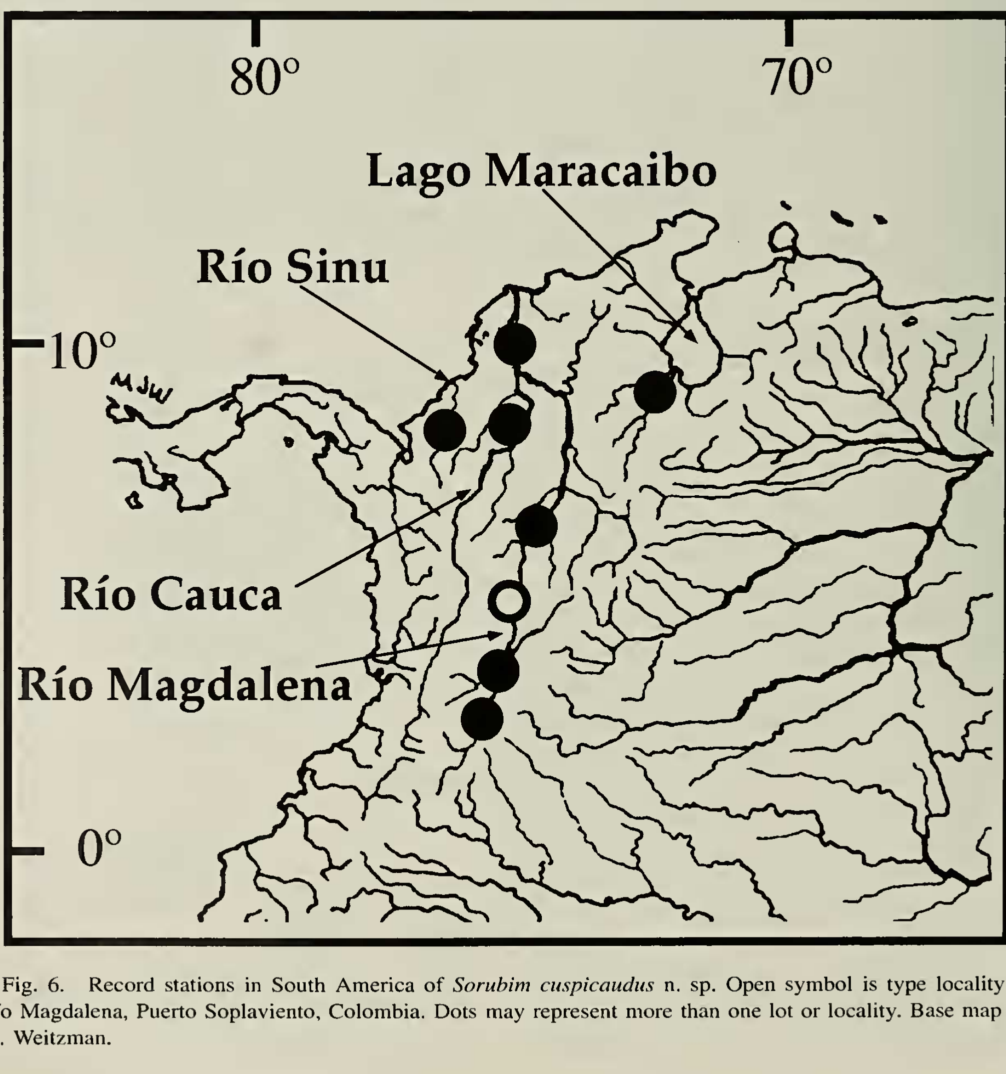


Fig. 6. Record stations in South America of *Sorubim cuspicaudus* n. sp. Open symbol is type locality in Río Magdalena, Puerto Soplaviento, Colombia. Dots may represent more than one lot or locality. Base map by M. Weitzman.

Table 8.—Frequency distribution of number of anal fin rays in species of *Sorubim* (Littman 1998).

Species	18	19	20	21	22	23	24	25	*n*	mean	*SD*
Sorubim lima		18	63	66	13				160	20.46	0.800
Sorubim n. sp.			5	35	47	25	8	1	121	21.96	1.004
S. cuspicaudus	1	9	7	2	1				20	19.65	0.933
S. trigonocephalus		1			2				3	21.00	1.732

toma sp.) have persisted during the entire time since the Cordillera of Bogota began to be an effective barrier against the intermigration of the fishes of the two sides." Additional support for this hypothesis can be found in Lundberg (1998), Lundberg et al. (1986) and Lundberg & Chernoff (1992). The occurrence of an endemic species of *Sorubim* west of the Andes Cordillera Oriental in the Magdalena basin is consistent with a pattern repeated among several other lowland fish groups that also have representatives in the Amazon or Orinoco basins (Vari 1988:350, Harold & Vari 1994: 1).

Additionally, the Maracaibo basin and Magdalena drainages are separated from each other by the Sierra de Perija, negating any direct contact between drainage populations of the same species. Historically, a paleo-Amazon/Orinoco river flowed north, draining into the Caribbean via Lago Maracaibo, a time when no major land barriers existed to divide the area (Lundberg et al. 1998, others). During the late Miocene (11–8 Ma), major uplift caused vicariant events, completely separating ancestral ranges of species into what is now the Lago Maracaibo basin, the Río Magdalena basin, and Pacific coastal drainages in northwestern Colombia.

The presence of *S. cuspicaudus* in both the Magdalena and Maracaibo basins but not east in the western Orinoco basin provides us with a glimpse into their evolutionary history but does not offer the total story. We suggest that ancestral populations of *S. cuspicaudus* were separated from the Orinoco basin species of *Sorubim* (i.e., *S. lima*) by tectonic events giving rise to the

Table 9.—Sheared principal component loadings for morphometric variables taken from the head of 45 *Sorubim lima*, 42 *Sorubim* n. sp., 16 *S. cuspicaudus*, and 3 *S. trigonocephalus*. Highest loading factors are in bold type.

Measurement	Sheared PC 2	Sheared PC 3
Standard length	0.198	0.139
Left anterior nostril to right anterior nostril	−0.328	0.075
Left posterior nostril to right posterior nostril	−0.292	0.030
Left anterior nostril to right posterior nostil	−0.247	0.097
Right anterior nostril left posterior nostril	−0.246	0.098
Left anterior nostril to posterior right eye	0.050	0.211
Left anterior nostril to left posterior nostril	0.044	**0.454**
Right anterior nostril to posterior left eye	0.052	0.212
Left posterior nostril to posterior left eye	0.196	0.301
Right posterior nostril to posterior right eye	0.195	0.279
Posterior left eye to posterior right eye	−0.169	−0.288
Posterior left eye to right pectoral origin	0.154	−0.308
Posterior left eye to left pectoral origin	**0.462**	−0.154
Posterior right eye to right pectoral origin	**0.475**	−0.157
Posterior right eye to left pectoral origin	0.151	−0.308
Left pectoral origin to right pectoral origin	−0.220	**−0.411**

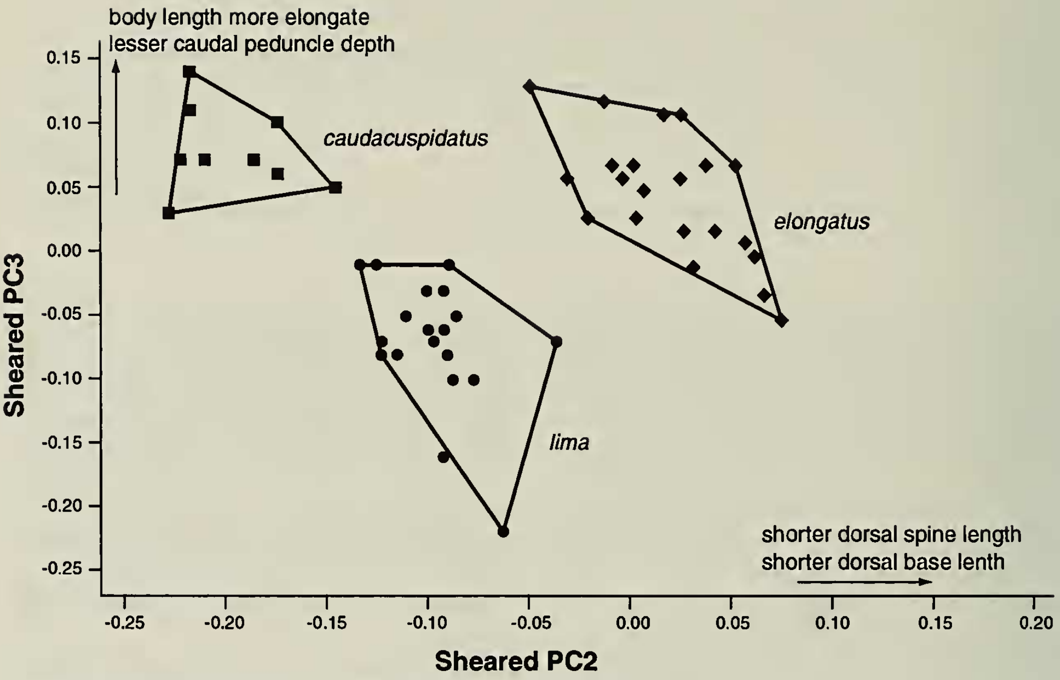


Fig. 7. Morphometric scores of body measurements on sheared PC axes 2 and 3 for 19 specimens of *Sorubim lima*, 21 specimens of *Sorubim* n. sp., and 9 specimens of *S. cuspicaudus* n. sp.

Oriental mountain range east of Lago Maracaibo (Lundberg et al. 1998, Galvis et al. 1997). At a minimum, *S. cuspicaudus* would have diverged from paleo-Amazon/Orinoco ancestors since the uplift of the Andean Cordillera Oriental during the late Miocene but before geological events leading to the uplift of the Sierra de Perija.

Currently, there are no published hypotheses to explain the historical relationships of *Sorubim*. Vari & Weitzman (1990) discussed the need to study phylogenetic relationships of fishes to develop historical biogeographic hypotheses. They stated that, "... the poor understanding of the recognizable species in South American freshwaters is compounded by the lack of sampling of the fauna." At the present time, preliminary morphological data still under preparation by the first author and collaborators show a sister-species relationship between *S. cuspicaudus* and *S. lima*. These findings, including a phylogenetic revision of *Sorubim*, will be presented in a later paper.

Nontype material.—The following list of material provides detailed locality descriptions of specimens examined for this paper. Comparative material of the other three species of *Sorubim* are listed in Littmann (1998); these data may be obtained from the authors. Specimens whose SL are marked with an asterisk represent those individuals used for the morphometric analyses.

Atlantic Ocean drainage. Colombia. Río Magdalena drainage. BMNH 1900.1.30.12–13, 2:299–353 mm SL, Baranquilla. 30 Jan 1900, Thomson. BMNH 1947.7.1.197, 157 mm SL, Baranquilla. 1 Jul 1947, Miles. CAS 149475, 175 mm SL*, Bolivar, Río San Jorge, San Marcos. Jun 1955, G. Dahl. CU 47915, 483 mm SL, Santander; Lake San Sylvestre by city of Barranca-Bermeja. 7 Sep 1962, J. D. Archer. FMNH 56220, 367 mm SL*, Honda. 28 Jan 1912, C. H.

Table 10.—Sheared principal component loadings for morphometric variables taken from the body of 19 *Sorubim lima*, 16 *Sorubim* n. sp., 8 *S. cuspicaudus*. Highest loading factors are in bold type.

Measurement	Sheared PC 2	Sheared PC 3
SL	0.198	0.111
Snout length	−0.006	−0.156
Head length	0.019	0.086
Snout tip to dorsal origin	0.072	0.117
Snout tip to pectoral origin	0.021	0.126
Pectoral length at base	−0.223	0.022
Dorsal length at base	**−0.543**	−0.217
Dorsal spine length	**−0.357**	−0.038
Pectoral origin to dorsal origin	0.012	−0.014
Pectoral origin to dorsal insertion	−0.056	−0.036
Pectoral insertion to dorsal origin	0.040	−0.030
Pectoral insertion to dorsal insertion	−0.030	−0.061
Posterior margin fleshy operculum to pelvic origin	0.138	0.108
Posterior margin fleshy operculum to pelvic insertion	0.089	0.075
Pelvic length at base	−0.288	−0.196
Pelvic origin to dorsal origin	−0.006	−0.128
Pelvic origin to dorsal insertion	0.181	−0.188
Pelvic insertion to dorsal insertion	0.215	−0.167
Pelvic insertion to adipose origin	0.198	0.087
Pelvic insertion to adipose insertion	0.090	0.208
Dorsal insertion to anal origin	0.156	0.145
Dorsal insertion to adipose origin	0.107	**0.338**
Pelvic insertion to anal origin	0.090	**0.342**
Anal origin to adipose origin	0.228	−0.271
Anal origin to adipose insertion	0.035	−0.082
Anal insertion to adipose origin	0.063	−0.068
Anal insertion to adipose insertion	0.264	**−0.367**
Anal length at base	0.007	−0.118
Adipose length at base	−0.186	**0.400**
Adipose insertion to anterior of caudal fin base	−0.037	−0.113
Anal insertion to anterior of caudal fin base	−0.269	0.165

Eigenmann. FMNH 57701, 2:305–311 mm SL*, at Puerto Berrio, elevation 429′. 24 Jan 1912, C. H. Eigenmann. FMNH 88180, 3:257–355 mm SL*, at Soplaviento. No date, C. H. Eigenmann. NRM 16254, 107 mm SL, Lower Río Magdalena drainage. No date, Olsson & Ragnar, of Centro de Investigacion de Ciencias Marinas, Cartagena. Río Sinu. NRM 14812, 239 mm SL*, Cordoba, Alto de Quimari, elevation 500 m. Apr 1949, K von Sneidern et al. Venezuela. Lago Maracaibo basin. MBUCV-V-13536, 5:345–380 mm SL, Estado Zulia. 23 Jan 1963, collector unknown.

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Literature Cited

Arboleda, S., M. Zarate, G. Vera, & C. Moreno. 1984. Evaluacion del esfuerzo y la captura pesquera durante la Subienda 1984 en la cuenca del Rio Magdalena, y analisis del estado actual de sus pesquerias. Informe Tecnico, inedito, INDERENA, San Cristobal, 39 pp.

Bayley, P. B. 1973. Studies on the migratory characin *Prochilodus platencia* Holmberg, 1889 (Pisces, Characoidea) in the Rio Pilcomayo, S. America.—Journal of Fish Biology 5:25–40.

———. 1981. Fish yield from the Amazon in Brazil: comparisons with African river yields and management possibilities.—Transactions of the American Fisheries Society 110:351–359.

———, & M. Petrere, Jr. 1989. Amazon fisheries: assessment methods, current status and management options. Pp. 385–398 *in* D. P. Lodge, ed., Proceedings of the International Large River Symposium.—Canadian Special Publication of Fisheries and Aquatic Sciences 106.

Bloch, M. E., & J. G. Schneider. 1801. M. E. Blochii Systema Ichthyologiae iconibus cx illustratum. Post obitum auctoris opus inchoatum absolvit, correxit, interpolavit Jo. Gottlob Schneider, Saxo. Berolini, Sumtibus Austoris Impressum et Bibliopolio Sanderiano Commissum. i-1x + 584 pp., 110 plS.

Bookstein, F. L., B. Chernoff, R. L. Elder, J. M. Humphries, Jr., G. R. Smith, & R. E. Strauss. 1985. Morphometrics in evolutionary biology. The Academy of Natural Sciences of Philadelphia, Special Publication 15.

Cailliet, G. M., M. S. Love, & A. W. Ebeling. 1996. Fishes, a field and laboratory manual on their structure, identification and natural history. Waveland Press, Inc., Prospect Heights, II. 194 pp.

Dahl, G. 1961. Nematognathous fishes collected during the Macarena Expedition 1959. Dedicated to the memory of the Colombian ichthyologist, Dr. Ricardo Lozano. Decd May 23rd, 1959. Part II: Pimelodidae, Callophysidae.—Novedades Colombianas v. 1(no. 6):483–514.

Dahl, G. 1971. Los peces del norte de Colombia. Inderena, Bogotá, 391 pp.

Day, J. A., & B. R. Davies. 1986. The amazon river system. Pp. 32–64 *in* B. R. Davies and K. F. Walker, eds., The ecology of river systems. Dr. W Junk Publishers, Dordrecht (Netherlands).

Eigenmann, C. H. 1920. The Magdalena basin and the horizontal and vertical distribution of its fishes.—Contribution from the Zoölogical Laboratory of Indiana University 177:21–34.

———, & R. S. Eigenmann. 1890. A revision of the South American Nematognathi or cat - fishes.—Occasional Papers of the California Academy of Science 1:1–508.

Eschmeyer, W. N. 1998. Catalog of fishes. California Academy of Sciences, San Francisco.

Escobar, J., M. Zárate, M. Valderrama, C. Lara, & C. Fonseca. 1983. Tallas mínimas y medias de maduración para 14 species ícticas de interés comercial de la cuenca Magdalénica (1978).—INDERENA. Revista Divulgación Pesquera, XXI (2):12 p.

Galvis, G., J. I. Mojica, & M. Camargo. 1997. Peces del Catatumbo. Asociación Cravo Norte, Santefé de Bogotá, D. C., 118 pp.

Goulding, M. 1980. The fishes and the forest: explorations in Amazonian natural history. University of California Press, Berkeley, 280 pp.

Harold, A. S., & R. P. Vari. 1994. Systematics of the trans-Andean species of *Creagrutus* (Ostariophysi: Characiformes: Characidae).—Smithsonian Contributions to Zoology 551:1–31.

Hubbs, C. L., & K. F. Lagler, 1974. Fishes of the Great Lakes region. Bulletin of the Cranbook Institute of Science 26.

Humphries, J. M., F. L. Bookstein, B. Chernoff, G. R. Smith, R. L. Elder, & S. G. Poss. 1981. Multivariate discrimination by shape in relation to size.—Systematic Zoology 30:291–308.

Hurtado, N. 1972. Aspectos biológicos del medio-alto Magdalena. Pp. 10–44 *in* INDERENA, Operación subienda 1972, Investigación Pesquera, Bogotá.

Jenkins, R. E., & E. A. Lachner. 1971. Criteria for analysis and interpretation of the American fish genera *Nocomis* Girard and *Hybopsis* Agassiz.—Smithsonian Contributions to Zoology 90.

Kapetsky, J. M., J. Escobar, P. Arias, & M. Zárate. 1977. Algunas espectos ecológicos de las ciénagas del plano inundable del Magdalena. Proyecto INDERENA-FAO, Bogotá, 28 pp.

Kner, R. 1858. Ichthyologische Beiträge. II. Abtheilung.—Sitzungsberichte Akademie Wissenschaften Wien 26(s. 373):373–448, pls. 1–9.

Leviton, A. E., & R. H. Gibbs, Jr. 1988. Standards in herpetology and ichthyology. Standard symbolic codes for institutional resource collections in herpetology and ichthyology: Supplement No. 1: additions and corrections.—Copeia 1988: 280–282.

Leviton, A. E., R. H. Gibbs, Jr., E. Heal, & C. E. Dawson. 1985. Standards in herpetology and ichthyology: Part 1. Standard symbolic codes for institutional resource collections in herpetology and ichthyology.—Copeia 1985:802–832.

Littmann, M. W. 1998. Revision of the South American shovelnose catfishes of the genus *Sorubim* (Siluriformes: Pimelodidae), with descriptions of two new species. Unpublished M.S. thesis, Southern Illinois University, Carbondale, 78 pp.

Lundberg, J. G. 1998. The stage for Neotropical fish diversification: a history of tropical South American rivers. Chapter 2, Pp. 13–48 *in* L. R. Malabarba, R. E. Reis, R. P. Vari, C. A. S. Lucena, and Z. M. S. Lucena, eds., Phylogeny and classification of Neotropical fishes. Mus. Ci. Technol. PUCRS, Porto Alegre.

Lundberg, J. G., & B. Chernoff. 1992. A Miocene fossil of the Amazonian fish *Arapaima* (Teleostei, Arapaimidae) from the Magdalena River region of Colombia-biogeographic and evolutionary implications.—Biotropica 24(1):2–14.

———, & L. McDade. 1986. On the South American catfish *Brachyrhamdia imitator* Meyers (Siluriformes, Pimelodidae), with phylogenetic evidence for a large intrafamilial lineage.—Notulae Naturae 463:1–24.

———, A. Machado-Allison, & R. F. Kay. 1986. Miocene characid fishes from Colombia: evolutionary stasis and extirpation.—Science 234:208–209.

———, F. Mago-Leccia, & P. Nass. 1991. *Exallodontus aguanai*, a new genus of Pimelodidae (Pisces: Siluriformes) from deep river channels of South America, and delimitation of the subfamily Pimelodidae.—Proceedings of the Biological Society of Washington 104:840–869.

———, P. Nass, & F. Mago-Leccia. 1989. *Pteroglanis manni* Eigenmann and Pearson, a juvenile of *Sorubimichthys planiceps* (Agassiz), with a review of the nominal species of *Sorubimichthys* (Pisces: Pimelodidae).—Copeia 1989:332–344.

Miles, C. 1947. Los peces del rio Magdalena (a field book of Magdalena fishes). Editorial El Grafico, Bogotá, 214 pp.

Miranda Ribeiro, A. de. 1920. Peixes (excl. Characinidae). *In*: Commissão de Linhas Telegraphicas Estrategicas de Matto-Grosso ao Amazonas. Historia Narural. Zoologia. No. 58 (Annexo 5): 1–15, 17 unnum. pls.

Novoa, D. F. 1989. The multispecies fisheries of the Orinoco River: development, present status, and management strategies. Pp. 422–428. *In*: D. P. Lodge, ed., Proceedings of the International Large River Symposium.—Canadian Special Publication of Fisheries and Aquatic Sciences 106.

Pothoff, T. 1984. Clearing and staining techniques. Pp. 35–37 *in* H. G. Moser, W. J. Richards, D. M. Cohen, M. P. Fahay, A. W. Lendall, Jr., and S. L. Richardson, eds., Ontogeny and systematics of fishes. An international symposium dedicated to the memory of Elbert Halvor Ahlstrom.—American Society of Ichthyologists and Herpetologists. Special Publication 1.

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, & W. B. Scott. 1991. World fishes important to North Americans. American Fisheries Society Special Publication 21. American Fisheries Society, Bethesda, Maryland.

SAS Institute Inc. 1997. SAS user's guide: statistics, version 5 edition. SAS Institute Inc., Cary, North Carolina.

Schaefer, S. A. 1991. Morphometric investigations in cyprinid biology. Pp. 55–82 *in* I. J. Winfield & J. S. Nelson, eds., Cyprinid fishes: systematics, biology, and exploration. Chapman and Hall, London.

Silfvergrip, A. M. C. 1996. A systemic revision of the neotropical catfish genus *Rhamdia* (Teleostei, Pimelodidae). Jannes Snabbtryck AB, and Enskede Offset AB, Stockholm, 156 pp., 8 pls.

Sioli, H. 1984. The Amazon. Limnology and landscape ecology of a mighty tropical river and its basin. W. Junk, Dordrecht, 763 pp.

Strauss, R. E., & F. L. Bookstein. 1982. The truss: body form reconstruction in morphometrics.—Systematic Zoology 31:113–135.

Taylor, W. R., & G. C. Van Dyke. 1985. Revised procedure for staining and clearing small fishes and vertebrates for bone and cartilage study.—Cybium 9:107–119.

Valderrama, M., & M. Zárate. 1989. Some ecological aspects and present state of the fishery of the Magdalena River basin, Colombia, South America. Pp. 409–421 *in* D. P. Dodge, ed., Proceedings of the international large river symposium.—Canadian Special Publication of Fisheries and Aquatic Sciences 106.

Vari, R. P. 1988. The Curimatidae, a lowland Neotropical fish family (Pisces: Characiformes); distribution, endemism, and phylogenetic biogeography. Pp. 313–377 *in* P. E. Vanzolini and W. R. Heyer, eds, Neotropical Distribution Patterns: Proceedings of a Workshop. Rio de Janeiro: Academia Brasiliera de Ciências.

———, & S. H. Weitzman. 1990. A review of the phylogenetic biogeography of the freshwater fishes of South America, pp. 381–393. *In*: Vertebrates in the tropics. G. Peters and R. Hutterer (eds.). Museum Alexander Koenig, Bonn.

Weyenbergh, H. 1877. Algunos nuevos pescados del Museo Nacional, y algunas noticias ictiológicas.—Actas Academy Nacional Ciencias Exactas 3:1–21, 4 pls.